CLAIMS

WE CLAIM:

1. A parametric ultrasonic system comprising:

an ultrasonic transducer assembly adaptable to provide ultrasonic signals at different angles from a plurality of voxels in a region of interest; and

a processor receiving the echo signals and extracting a parametric measurement for each of the voxels based on multiple frequency spectra from ultrasonic signals at different angles.

2. The parametric ultrasonic system of claim 1 wherein the processor produces a parametric measurement of scatterer size.

3. The parametric ultrasonic system of claim 2 wherein the processor determines a spectrum of a portion of at least one ultrasonic signal associated with a voxel and matches the spectrum to spectra of materials having known scatterer size to produce the parametric measurement of scatterer size.

4. The parametric ultrasonic system of claim 3 wherein the spectrum of the voxel and the spectra of the materials having known scatterer size are corrected prior to matching for variations in the spectra caused by the measurement environment.

5. The parametric ultrasonic system of claim 4 wherein the correction of the spectra corrects for variations caused by characteristics of the transducer assembly and a signal path between the voxel and the transducer assembly through a standard material.

6. The parametric ultrasonic system of claim 1 wherein the processor produces a parametric measurement of scatterer spacing.

7. The parametric ultrasonic system of claim 6 wherein the processor determines a cepstrum of a portion of at least one ultrasonic signal associated with a voxel to determine the scatterer spacing.

8. The parametric ultrasonic system of claim 1 wherein the processor produces a parametric measurement of scatterer number density.

9. The parametric ultrasonic system of claim 8 wherein the processor compares a spectrum of a portion of at least one ultrasonic signal associated with a voxel and matches the spectrum to spectra of materials having known scatterer size, and then scales the matched spectrum of the known material to the spectrum associated with the voxel to determine scatterer number density.

10. The parametric ultrasonic system of claim 8 wherein the processor compares the kurtosis of a portion of at least one echo signal associated with a voxel and matches the kurtosis to that derived from materials having known scatterer size to the spectrum associated with the voxel to determine scatterer number density.

11. The parametric ultrasonic system of claim 1 wherein the processor produces a parametric measurement of broadband ultrasonic attenuation.

12. The parametric ultrasonic system of claim 11 wherein the processor determines a spectrum for at least one ultrasonic signal for two adjacent voxels in the region of interest and determines a difference of the spectra of the adjacent voxels and takes the slope of the difference to determine the broadband ultrasonic attenuation.

13. The parametric ultrasonic system of claim 11 wherein the processor maps the parametric measurement of each voxel to a display value and including a display screen for producing an image of the region of interest showing the display values.

14. The parametric ultrasonic system of claim 1 including a sensor attached to the ultrasonic transducer assembly providing a position signal for each of the different angles and wherein the processor receives the position signal for each ultrasonic signal to match corresponding portions of the ultrasonic signals to each voxel for the extraction of the parametric measurement for each voxel.

15. The parametric ultrasonic system of claim 1 wherein the processor includes a correlator correlating the ultrasonic signals over each voxel to match corresponding portions of the ultrasonic signals to each voxel for the extraction of the parametric measurement for each voxel.

16. The parametric ultrasonic system of claim 1 wherein the processor produces a parametric measurement from the ultrasonic signals taken at angles differing by no more than 5 degrees.

17. The parametric ultrasonic system of claim 1 wherein the ultrasonic transducer assembly is an ultrasonic transducer with a mechanical scanning mechanism for moving the ultrasonic transducer to obtain the ultrasonic signal at the different angles.

18. The parametric ultrasonic system of claim 1 wherein the ultrasonic transducer assembly includes a phased array transducer scannable by phasing of elements of the array to collect the ultrasonic signals at different angles.

19. The parametric ultrasonic system of claim 1 wherein the processor extracts parametric measurements from voxels aligned within a single image plane.

20. The parametric ultrasonic system of claim 1 wherein the processor extracts parametric measurements from voxels distributed over a volume extending for multiple voxels in two dimensions perpendicular to a direction of ultrasonic propagation.

21. A parametric ultrasonic system comprising:

an ultrasonic transducer assembly adaptable to provide a series of ultrasonic signals at different angles of a plurality of voxels in a region of interest; and

a processor receiving the echo measurements and extracting a parametric measurement for each of the voxels selected from the group consisting of scatterer size in the material of the voxel, scatterer spacing in the material of the voxel,

scatterer number density in the material of the voxel, and attenuation of the material of the voxel.

22. A method of making parametric ultrasonic measurements comprising the steps of:

(a) acquiring ultrasonic signals at different angles of a plurality of voxels in region of interest;

(b) obtaining the frequency spectra of the multiple ultrasonic signals;

(c) for each voxel, extracting parametric measurements as a function of frequency spectra of multiple ultrasonic signals at different angles; and

(d) outputting the parametric measurements.

23. The method of making parametric ultrasonic measurements of claim 22 wherein the parametric measurement is scatterer size.

24. The method of making parametric ultrasonic measurements of claim 23 including the step of matching at least one spectrum associated with each voxel to spectra of materials having known scatterer size to produce the parametric measurement of scatterer size.

25. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are made through human tissue.

26. The method of making parametric ultrasonic measurements of claim 25 including the step of correcting the spectra for variations caused by the transducer characteristics and a signal path between the transducer and the voxels through a standard material approximating human tissue.

27. The method of making parametric ultrasonic measurements of claim 22 wherein the parametric measurement is scatterer spacing.

28. The method of making parametric ultrasonic measurements of claim 27 including the step of determining at least one cepstrum associated with each voxel to determine the scatterer spacing.

29. The method of making parametric ultrasonic measurements of claim 22 wherein the parametric measurement is scatterer number density.

30. The method of making parametric ultrasonic measurements of claim 29 including the steps of matching at least one spectrum associated with each voxel to spectra of known materials of given scatterer size and scaling the matched spectra of the known materials to the spectra associated with the voxels to determine scatterer number density.

31. The method of making parametric ultrasonic measurements of claim 22 wherein the parametric measurement is broadband ultrasonic attenuation.

32. The method of making parametric ultrasonic measurements of claim 31 including the steps of comparing the spectra associated with adjacent voxels in the region of interest and determining a difference of the spectra of the adjacent voxels to measure the broadband ultrasonic attenuation.

33. The method of making parametric ultrasonic measurements of claim 22 wherein the step of outputting maps the parametric measurement of each voxel to an image value to display an image of the region of interest composed of the values.

34. The method of making parametric ultrasonic measurements of claim 22 including the step of receiving a series of position signals from an ultrasonic transducer during the step of acquiring ultrasonic signals and using the position signals to match corresponding portions of the ultrasonic signals by voxel for the extraction of the parametric measurement for each voxel.

35. The method of making parametric ultrasonic measurements of claim 22 including the step of correlating values of the ultrasonic signals over each voxel to determine a maximum correlation and using the maximum correlation to match corresponding portions of the ultrasonic signals by voxel for the extraction of the parametric measurement for each voxel.

36. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are taken at angles differing by no more than 5 degrees.

37. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are taken at angles differing by less than one degree.

38. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are taken at angles ranging less than 180 degrees.

39. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are taken at angles ranging less than 90 degrees.

40. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are taken of voxels aligned within a single image plane.

41. The method of making parametric ultrasonic measurements of claim 22 wherein the ultrasonic signals are taken of voxels distributed over a volume extending for multiple voxels in two dimensions perpendicular to a direction of ultrasonic propagation.